2000-2001 Maine Forest Service Report
on
Forestry Best Management Practices
Use and Effectiveness
in Maine

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and
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Executive Summary

Best Management Practices (BMPs) refers to a broad range of recommended techniques for minimizing impacts to water quality during timber harvesting. (Some of these same techniques are required by various state and local statutes). Though BMPs have been known and implemented for many years, comprehensive data on their use and effectiveness have been lacking, with the exception of few studies.

The Maine Forest Service and FORAT (Forest Advisory Team, a broad stakeholder group) developed a new methodology and data sheet for monitoring BMPs on timber harvest sites in 1999, based in part on the 1996 Briggs report[1]. The Maine Forest Service instituted random, statewide monitoring of BMPs on timber harvesting operations in March of 2000. The objectives of this effort are to assess use and effectiveness of BMPs in Maine, and to evaluate trends over time. Neither compliance with nor enforcement of statutes or regulations was among the goals of this effort.

This report presents findings from the first 15 months (March 2000 to May 2001). MFS continues the monitoring effort as a regular part of field activities, and expects to generate annual reports.

In this study, key findings regarding the use and effectiveness of BMPs are as follows:

- **Forty-three percent of harvest sites examined in the study do not have surface water bodies in the immediate harvest area.**
- **Appropriate use of BMPs minimizes water quality impacts**. Harvest sites in this study with appropriate use of BMPs across the site always prevented major soil movement and sedimentation of water bodies.
- **Inadequate BMP use can lead to soil movement and discharge to water bodies.** Harvest sites in this study with major soil movement and soil delivery to water bodies always were sites where BMPs were minimally applied or not used.
- **BMPs were used appropriately or with a "good attempt" on 62.4% of harvested sites where water bodies were found.**
- **There are several important areas where effective implementation of BMPs is critical, including skid trails, stream crossings, filter areas, haul roads, and harvesting/residual shade in riparian areas.** Harvesting during appropriate conditions, such as on frozen ground, can help minimize sediment movement and delivery to surface waters.

The study developed additional information on the context in which BMPs are applied:

- **Intermittent and first order streams are the types of water bodies most frequently found in harvest areas.** These two stream types account for 78% of the water bodies encountered.
- **BMP use and effectiveness do not appear to be substantially different based on landowner type (non-industrial private landowners or commercial landowners).**
- **BMP use and effectiveness do not appear to be substantially different based on the involvement of licensed foresters in the harvest. However, the degree of**

actual involvement in harvest planning and supervision by foresters was not closely examined.

- **Preexisting conditions resulting from past operations can play a role in BMP use, and in some situations may influence BMP effectiveness.**

The study results suggest future needs both in encouraging BMP use, and in refining the methodology:

- **Overall, trends in BMP use and effectiveness rates appear to be positive, but are not easily quantifiable due to methodological differences between this study and the 1996 Briggs report. However, continued efforts to encourage use of BMPs appear to be warranted.** Ongoing monitoring by MFS will provide more directly comparable data and help establish trends in use and effectiveness.
- **Sampling of sites results in a broad (but not necessarily proportional) representation of harvesting in Maine by several criteria, including forest ownership, season of harvest, type of equipment, silvicultural type, and geographic distribution.** Refinements in the sampling and methodology may improve the study and broaden the information it provides.

[1] Briggs, R., Kimball, A., Cormier, J. 1996. Assessing compliance with BMPs on Harvested Sites in Maine: Final Report. University of Maine, Cooperative Forestry Research Unit Research Bulletin 11. 35 pp.

2000-2001 Maine Forest Service BMP Monitoring Report

Introduction

The 118th Maine Legislature directed Maine Forest Service (MFS) to evaluate the progress made by timber harvesting operations in implementing forestry Best Management Practices (BMPs) to protect water quality (PL 1997, Chapter 648). This call from the legislature and from the broader conservation community was in part in response the Briggs study of 1996[1], a joint effort by MFS, University researchers, and FORAT, or Forestry Advisory Team. FORAT is a broad-based advisory group of stakeholders, in existence since the early 1990s, whose mission is to advise MFS and the Department of Environmental Protection on water quality issues related to forest management.

The Briggs study had reported on BMP use and effectiveness by examining appropriate or recommended BMPs in detail on 120 sites. They concluded that applicable BMPs work well when implemented, but that use of individual BMPs varied from very low to very high (25%-96% of applicable sites). There was broad recognition that a process was needed to provide regular, statewide information on trends in BMP use and effectiveness. Such information would help focus efforts to educate foresters, loggers, and landowners in BMP use, and would enable MFS to assess implications of policy directions more effectively. The process could also be modified in future to focus on other important issues as these are identified.

MFS, with the assistance of FORAT, developed a monitoring protocol to conduct regular, statewide monitoring of BMP use and effectiveness on timber harvesting operations. The effort intended to increase efficiency over the Briggs methodology, establish long-term monitoring and at the same time focus attention on activities and impacts more directly associated with water quality. Monitoring, as opposed to in-depth research, is warranted to capture a broad snapshot, over time, of BMP implementation on timber harvests statewide. Trends in rates of BMP use and effectiveness are of key interest. While the Briggs report serves as a baseline, and current monitoring dovetails in some respects with their methods, MFS has adopted a broader approach in order to focus on important issues (e.g. controlling soil disturbance), rather than individual practices (e.g. use of waterbars). There is general agreement, from FORAT and others, that Maine Forest Service is the entity best equipped to conduct such monitoring.

MFS field-tested a monitoring protocol and data sheet in 1999, made additional modifications upon review by FORAT, and trained MFS field staff in the use of the sheet. The methodology rates **BMP use** and BMP "**effectiveness**" (or impact to surface waters) independently. "BMP use" is evaluated relating to specific issues/areas of the harvest, based on a range of applicable BMPs. "Effectiveness" is more accurately an assessment of **impact** of harvest activities on water quality and is rated in terms of soil movement and soil delivery to surface waters. Sites are selected randomly in nine districts statewide, based on Forest Operations Notifications (FON) submitted to MFS, though landowner permission to conduct the study is requested. The methodology does not assess compliance with state statutes, regulations, or local ordinances.

Regular, monthly monitoring of randomly selected field sites by MFS Field Foresters and Forest Rangers began in March, 2000. **This report is the first compilation of data under**

this monitoring effort, and is based on analyses of the first 15 months of data, collected from March 2000 to May 2001. In this period, 383 sample sites were drawn at random, of which 317 resulted in field monitoring of harvested sites. Data collection by MFS personnel focuses on areas of recent harvest activity and presence of surface water. Data for a given site are not necessarily representative of the entire harvest area, or of the work of any persons involved in the harvest. Similarly, the number or dimensions of water bodies affected by these sites is not quantified. MFS expects to continue BMP monitoring indefinitely, and report annually on the most recent 12 months of data. (Readers interested in more detailed information on the methodology and/or data sheet are encouraged to contact the Maine Forest Service at 1-800-367-0223 instate, or (207) 287-2791.)

A quality control team composed of FORAT volunteers took part in training sessions, and reviewed implementation of the program by visiting all 9 districts, one or two each month. The team observed monitoring in all districts by February 2001. Modifications of the monitoring methodology, based in part on the experience of the quality control team, are being considered. The team played an important role in assuring consistent application of the monitoring protocol.

Field monitoring, analyses and reporting are being completed with existing staff resources, as no new funds were allocated for this program. As much as possible, field time is coordinated with other MFS activities.

Results

Presence of water bodies

Random selection of notified harvests from the FON database resulted in 383 selected sample sites. Seventy-one of these sites were alternate sites, used primarily because landowner permission had been denied. Based on field reconnaissance, 29 sites had not been harvested. An additional 18 sites were not accessible, due to unplowed roads or locked gates. BMP data could not be collected on 19 sites because of deep snow in the winter of 2000-2001.

Water bodies were found on 181 (57.1%) of the 317 harvested sites. Where water bodies were found, intermittent (69 sites or 38.1%) and first-order (73 or 40.3%) streams were by far the most common type of surface water. Second-order streams (17 or 9.4%), third and larger order streams (7 or 3.9%), lakes (8 or 4.4%), and non-forested wetlands (7 or 3.9%) were also found on some sites.

On the remaining 136 sites (42.9%) no water bodies were found within or immediately adjacent to the harvest area or the harvest access road immediately associated with the harvest. The study did not directly assess whether harvest planning, layout, or site selection was responsible for active avoidance of surface water. It seems likely that planning/avoidance occurred on at least some proportion of these sites, while passive/random avoidance accounts for the remainder of the sites without water bodies.

Overall BMP Use and "Effectiveness"(Water Quality Impact)

BMP use and BMP effectiveness on each site were examined within 5 broad categories of activity - skid trail channeling of water, temporary (in-woods) stream crossings, logging filter strips, haul road stream crossings, and haul road filter strips and drainage systems. Within each of these categories, 2-5 subcategories of related issues were rated in terms of whether applicable BMPs were applied, and whether soil movement and delivery to surface waters occurred.

BMP use and effectiveness overall are analyzed for the 181 sites where water bodies were found (Table 1). Each site was assigned an "overall" rating for both use and effectiveness at each site that reflected appropriate use of applicable BMPs and prevention of impacts to water bodies. First, the lowest subcategory score within each category for both use and effectiveness was assigned to the category itself. Then, the lowest of 5 category ratings was assigned to the site as a whole. Hence the overall use ratings highlight whether BMP practices were not implemented or were not implemented correctly anywhere on the site. Similarly, the overall effectiveness ratings identify whether soil movement or sedimentation of water bodies occurred in one or more locations on the site.

Table 1. Overall BMP Use and Effectiveness

	181 sites	
BMP Use	*n*	*%*
BMPs not applied*	46	*25.4*
Minimal attempt	21	*11.6*
Good attempt, needs improvement	38	*21.0*
BMPs used after the fact to correct an existing problem	1	*0.6*
BMPs used appropriately	75	*41.4*
	181 sites	
	n	*%*
BMP Effectiveness		
Ineffective, major soil movement, soil delivered to water body	13	*7.2*
Ineffective, minor soil movement, minimal soil delivered to water body	47	*26.0*
Soil movement, soil does not reach water body	37	*20.4*
Negligible soil movement	84	*46.4*
**where recommended/applicable*		

Of the 46 sites where BMP use was rated "not applied" in at least one category, 25 of these sites had this rating in 2 or more categories.

However, 25 sites where BMP were not applied or minimally applied had negligible soil movement and/or no delivery to surface waters. In addition, 75 sites where BMPs were used appropriately in all categories never had "major soil movement, soil delivered to surface waters".

Of the 13 sites that had at least one instance of "ineffective, major soil movement, soil delivered to water body", 10 had multiple sources of sedimentation. Five of these sites had instances of "major soil movement" in 2 or more categories, and 5 had at least one instance of "minor soil movement" in addition to "major soil movement". All of these 13 sites had BMPs either "not applied" or "minimal attempts" at BMP application. Ten sites with "minor soil movement" resulted from BMP use rated as "good attempt, needs improvement".

These findings suggest that BMPs are effective in protecting water quality when used appropriately, while inadequate BMP use can result in impacts to water quality.

Harvesting at appropriate time of year

Observers assessed whether harvests took place under frozen or non-frozen conditions. This assessment was based on the time of the harvest, not the time of the survey (unless the harvest was active), and identifies sites that, based on the best information obtained by the observer, were harvested under winter conditions (snow-covered and/or frozen soil). Harvests were conducted on frozen ground in 155 of 317 harvests (48.9%).

Harvests where water bodies were found (Table 2) appeared to be slightly more likely to have been conducted on frozen ground (99 of 181 sites, or 55%) than harvests where no water bodies were found (56 of 136 sites, or 41%).

BMP use and effectiveness ratings are slightly higher for sites harvested on frozen ground. The differences in BMP use ratings likely reflect (in part) the recognition by monitors that harvesting under frozen ground conditions is itself an important BMP that can prevent exposure of mineral soil. At the same time, higher effectiveness ratings for "frozen ground" may also reflect the fact that soil movement itself may be effectively reduced under frozen conditions.

Table 2. Ground Conditions

	Frozen ground (99 sites)		Non-frozen ground (82 sites)	
BMP Use	*n*	*%*	*n*	*%*
BMPs not applied	19	*19.2*	27	*32.9*
Minimal attempt	12	*12.1*	9	*11.0*
Good attempt, needs improvement	20	*20.2*	18	*22.0*
BMPs used after the fact to correct an existing problem	1	*1.0*	0	*0*
BMPs used appropriately	47	*47.5*	28	*34.1*
BMP Effectiveness				
Ineffective, major soil movement, soil delivered to water body	5	*5.1*	8	*9.8*
Ineffective, minor soil movement, minimal soil delivered to water body	21	*21.2*	26	*31.7*
Soil movement, soil does not reach water body	23	*23.2*	14	*17.1*
Negligible soil movement	50	*50.5*	34	*41.5*

BMP Use and Effectiveness by BMP Category

Use and effectiveness on each site with a water body were rated independently in 5 categories of both logging and haul road BMPs, including

- Skid trail channeling of water
- Temporary (in-woods) stream crossings
- Filter strips (in harvested areas)
- Haul road stream crossings, and
- Haul road filter strips and drainage systems.

Within each of these categories, 2-5 subcategories were individually scored. Note that these data only reflect the 181 sites where water bodies were found. In addition, "effectiveness" or impact to surface water was rated independently of BMP use, on all sites, not only those where BMPs were applied appropriately.

BMP use and BMP effectiveness for each category were obtained by assigning the lowest rating in all subcategories to the category as a whole. Rate of BMP use is assessed based on the observers' assessment of whether applicable BMPs had been implemented to address the issue presented by the subcategory. BMP "effectiveness" is rated for each subcategory based on observed sediment movement and delivery to water bodies (and is not a subset of sites based on BMP use). BMP categories are discussed individually below.

In general, rates of both use and effectiveness of BMPs vary somewhat by category (Table 3), though the range is not broad. Logging BMPs are applied effectively somewhat more often than haul road BMPs. At the same time, both temporary and haul road stream crossings have lower rates of BMP application. Soil movement and delivery to surface waters occurred in all categories, though stream crossings again had more frequent instances. Logging filter strips had both the highest rates of BMP use and the fewest occurrences of sediment delivery to surface waters.

Tables 3(a) and (b) are shown in Appendix 1, and present the same information in the form of matrices that relate BMP Use and BMP Effectiveness ratings. Broadly, they add emphasis to the finding that prevention of soil movement and delivery to surface waters is strongly related to implementation of BMPs. At the same time, failure to use BMPs did not always result in observed sedimentation at the time of the monitoring.

Skid Trail Channeling of Water

Skid trail channeling of water was assessed on 169 sites, but deemed "not applicable" on 12 sites. Skid trail channeling of water included 3 subcategories; skid trail channeling of water into road ditches or drainage systems; on intact forest floor in to water bodies, and on exposed mineral soil into water bodies. Most instances of low BMP use and ineffectiveness appear to involve all 3 subcategories.

Temporary (Logging) Stream Crossings

A total of 83 stream crossings were assessed in each of 3 subcategories; was the crossing stabilized; continued soil movement due to the crossing; crossing structure removed and closed out. All but 4 of these were crossings of intermittent or first order perennial streams.

No crossing structure was used at 40 sites, slash at 22 sites, logs/pole fords at 11 sites, temporary culverts at 5 sites, and temporary bridges at 5 sites. (No stream crossings were found on the remaining 98 sites, which may be the result of planning or passive avoidance.)

The 21 sites where BMP use was rated "not applied" included all types of crossings. The 5 sites which had at least one instance of "ineffective, major soil movement, soil delivered to water body" were all crossings with no structure or slash only, and minimal or no application of BMPs in at least one subcategory.

Logging Filter Strips
Filter strips were assessed at 156 of the 181 sites with water bodies, scored in each of 4 subcategories: exposed mineral soil in filter strip; ruts/channeling of water in filter strip; abatement measures; soil movement in filter strip.

Haul Road Stream Crossings
A total of 76 haul road stream crossings were assessed in 2 subcategories: crossing stabilized (bank to bank); continued soil movement attributed to crossing (including approaches). Most (63) of these were crossings were of intermittent or first order perennial streams, while 10 were of larger order streams, and 3 were wetland crossings. Haul road stream crossings used no crossing structure at 3 sites, fords at 2 sites, log crossings at 1 site, culverts at 59 sites, and bridges at 12 sites. (No stream crossings were found on the remaining 105 sites. In many cases haul roads were minimal, with log landings next to permanent public/private roads.)

Three sites (3.9%) had at least one instance of "ineffective, major soil movement, soil delivered to water body". All of these were culvert crossings.

Haul Road Filter Strips and Drainage Systems
Haul road filter strips and drainage systems were assessed (deemed applicable) on 75 sites. BMP effectiveness rankings for this category are based on 3 subcategories; exposed mineral soil in filter strip outside road profile; road drainage system functioning without soil movement; road drainage system discharges directly into the water body. Haul roads had been constructed within filter strips at 18 sites. None of the 3 sites (4.0%) that had at least one instance of "ineffective, major soil movement, soil delivered to water body" were on roads constructed within the filter strip.

Table 3. BMP Use and BMP Effectiveness, by BMP Category										
	Skid trail channeling of water		Temporary (logging) Stream Crossings		Logging Filter Strips		Haul Road Stream Crossings		Haul Road Filter Strips & Drainage Systems	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
BMP Use	(169 sites)		(83 sites)		(156 sites)		(76 sites)		(75 sites)	
BMPs not applied	20	*11.8*	21	*25.3*	18	*11.5*	9	*11.8*	14	*18.7*
Minimal attempt	12	*7.1*	12	*14.5*	4	*2.6*	11	*14.5*	8	*10.7*
Good attempt, needs improvement	25	*14.8*	15	*18.1*	12	*7.7*	20	*26.3*	15	*20.0*
BMPs used after the fact to correct an existing problem	1	*0.6*	1	*1.2*	0	*0.0*	0	*0.0*	0	*0.0*
BMPs used appropriately	111	*65.7*	34	*41.0*	122	*78.2*	36	*47.4*	38	*50.7*
BMP "Effectiveness" (Water Quality Impact)	(169 sites)		(83 sites)		(156 sites)		(76 sites)		(75 sites)	
Ineffective, major soil movement, soil delivered to water body	4	*2.4*	5	*6.0*	4	*2.6*	3	*3.9*	3	*4.0*
Ineffective, minor soil movement, minimal soil delivered to water body	20	*11.8*	14	*16.9*	5	*3.2*	28	*36.8*	15	*20.0*
Soil movement, soil does not reach water body	26	*15.4*	14	*16.9*	13	*8.3*	8	*10.5*	11	*14.7*
Negligible soil movement	119	*70.4*	50	*60.2*	134	*85.9*	37	*48.7*	46	*61.3*

Context for BMP Use and Effectiveness

Data collected for each harvest site where water bodies occurred provide additional information on the operational and human context in which BMPs are applied.

Water bodies

Water bodies affected by sediment delivery, whether major or minor, are overwhelmingly small streams, reflecting in large measure the proportion of sites found with these water bodies. Of 60 total sites where sediment delivery occurred, 54 of them involved intermittent or first order streams, while 4 involved second order streams and 2 occurred in wetlands.

Sites where BMP use was rated "not applied" or "minimal attempt" similarly involved primarily small streams (56 of 67 sites), though these ratings occurred one or more times in connection with second and third order streams, lakes, and non-forested wetlands as well.

Ownership distribution

Of the 317 harvested sites, 230 (72.6%) were on non-industrial private forests, and 68 (21.5%) were on commercial forest ownerships (industry-owned forests or large ownerships

managed primarily for commercial timber production). The remaining 19 sites (5.9%) were primarily publicly owned (state or municipal). This ownership distribution of sampled sites is not representative of actual acres harvested by various owner groups. Statewide harvesting data from 2000 show[2] that approximately 57% of harvested acres were on commercial ownerships, while 40% of harvested acres were on non-industrial, private ownerships.

Of the sites with water bodies (Table 1), non-industrial private forests were nearly twice as well represented as commercial forest ownerships (114 sites (62.9%) vs. 59 sites (32.5%), respectively). A few sites with water bodies were found on public ownerships (7 sites) and other ownerships (1 site).

BMPs are applied "appropriately" or "good attempt" roughly equally by non-industrial private landowners and commercial landowners (Table 4). A similar percentage of sites have major sediment movement and delivery to surface waters, though minor soil movement/delivery to water bodies occurs slightly more frequently on commercial ownerships (as a proportion of all sites). This difference appears to reflect the considerably lower presence of haul roads on non-industrial vs. commercial ownerships (29 vs. 46 sites with haul roads, respectively).

Table 4. BMP Use and Effectiveness by Ownership

	Non-industrial private (114 sites)		Commercial (59 sites)	
	n	*%*	*n*	*%*
BMP Use				
BMPs not applied	30	*26.3*	14	*23.7*
Minimal attempt	12	*10.5*	9	*15.3*
Good attempt, needs improvement	19	*16.7*	18	*30.5*
BMPs used after the fact to correct an existing problem	1	*0.9*	0	*0*
BMPs used appropriately	52	*45.6*	18	*30.5*
BMP Effectiveness				
Ineffective, major soil movement, soil delivered to water body	8	*7.0*	5	*8.5*
Ineffective, minor soil movement, minimal soil delivered to water body	27	*23.7*	20	*33.9*
Soil movement, soil does not reach water body	23	*20.2*	12	*20.3*
Negligible soil movement	56	*49.1*	22	*37.3*

Forester involvement

"Forester involvement" on individual harvest sites is based primarily on information from the Forest Operations Notification, supplemented by personal/local knowledge of the observers. No distinction is made regarding the level of involvement of foresters in planning, laying out, or supervising harvests. (Information on certification or training level of involved loggers was not available on most sites, and was not included in the monitoring.) Therefore, the following information should be regarded as providing, at best, an incomplete understanding of foresters' influence on BMP use and effectiveness.

Maine Licensed Foresters were involved on 152 (47.9%) of the 317 harvested sites overall. By landowner type, foresters were involved on 55 of 68 (80.9%) harvests on commercial ownerships, similar to the level of forester involvement reported for commercial landowners on a statewide basis in 2000[3] (79.1%). Foresters were involved on 82 of 230 (35.7%) harvests on non-industrial private ownerships, again similar the proportion of harvests with a forester reported for the state in 2000 (34.8%).

Foresters were involved on 103 (56.9%) of 181 harvested sites with water bodies (Table 5), a somewhat higher proportion than for all harvested sites. Again, for non-industrial private owners, the proportion of sites with foresters was less (46 of 114 sites, or 40.4%) than for commercial ownerships (49 of 59 sites, or 83.1%).

"Forester involvement" as determined in this study does not appear to increase either the rate of application of BMPs or the effectiveness in preventing soil movement and delivery to water bodies. In fact sites with no forester involved were slightly more likely to have all BMPs used appropriately and to ensure negligible soil movement on site. However, more information on what foresters' roles were in planning and supervising the harvest on individual sites could shed light on these findings. Similar information on the degree of understanding and application of BMPs by loggers and landowners would further clarify this aspect of BMP use and effectiveness.

Table 5. Forester Involvement

	Forester involved (103 sites)		No Forester (78 sites)	
	n	*%*	*n*	*%*
BMP Use				
BMPs not applied	28	*27.2*	18	*23.1*
Minimal attempt	12	*11.7*	9	*11.5*
Good attempt, needs improvement	24	*23.3*	14	*17.9*
BMPs used after the fact to correct an existing problem	0	*0*	1	*1.3*
BMPs used appropriately	39	*37.9*	36	*46.2*
BMP Effectiveness				
Ineffective, major soil movement, soil delivered to water body	9	*8.7*	4	*5.1*
Ineffective, minor soil movement, minimal soil delivered to water body	29	*28.2*	18	*23.1*
Soil movement, soil does not reach water body	21	*20.4*	16	*20.5*
Negligible soil movement	46	*42.7*	40	*51.3*

Pre-existing conditions

Observers assessed whether BMP choices and effectiveness were affected by "pre-existing conditions", generally relating to previous operations.

Existing haul roads and/or haul road stream crossings were most often identified as pre-existing conditions, and were identified as factors in BMP application on 48 of 75 haul road

stream crossings, 33 of 60 haul road filter strips, and 39 of 71 drainage systems. Pre-existing conditions were less common in logging areas, and involved 19 of 169 sites where skid trail channeling of water was assessed, 17 of 83 temporary (logging) stream crossings, and 12 of 156 logging filter strips.

No application or minimal application of BMPs occurred on 12 of 67 sites. Pre-existing conditions were also associated with sediment movement and delivery to surface waters on some sites. One third of 60 sites where major or minor soil movement and delivery to surface waters occurred involved pre-existing conditions.

Residual shade on water bodies

Harvest sites examined in this project were predominantly partial harvests (272 of 317, or 85.8%). The remaining harvests were overstory removal (4.7%) or clearcut (9.5%) harvests. These proportions appear to be similar, but are not directly comparable, to proportions of acres harvested statewide in 2000 by selection, shelterwood, and clearcut harvest methods (respectively, 61.9%, 34.6%, and 2.4%). (A large proportion of "shelterwood" harvests are likely partial, first-stage shelterwood cuts, while other are likely final, overstory removal harvests.)

Similarly, harvests on sites with water bodies were predominantly partial harvests (156 sites), with 13 clearcuts and 12 overstory removal harvests.

Residual shade on water bodies after harvesting was evaluated on 161 sites. (On the remaining 20 sites with water bodies, either road issues alone were assessed, or the harvesting was far enough away from the stream in question that shade retention was deemed by the observer to be "not applicable".)

Observers were asked to rate broadly the reduction of shade due to harvesting, based on professional judgment, in the following categories: "harvest with no shade reduction"; "harvest with adequate shade"; "harvest with partial shade"; "harvest with no residual shade". Current BMPs recommend leaving a windfirm stand of approximately 60% of pre-harvest stand volume, within the filter strip. Observers were given no further guidance in distinguishing between "adequate" and "partial" shade, though the rating of "partial" shade occurs between "no residual shade" and "adequate" shade, and strongly implies that the observer believed existing residual shade was inadequate. An additional category of "shade from other source than trees" was seldom applied.

Harvests resulted in no reduction in shade on 85 (52.8%) sites, and left "adequate" shade on 51 (31.7%) sites. Five sites were harvested where residual shade was provided by a source other than trees.

There were 7 sites (4.3%) where no residual shade was left, and 13 sites (8.1%) where "partial" (but presumably inadequate) shade was left. Of these 20 sites, 10 involved intermittent streams, 7 involved first-order streams, and the remaining 3 included 1 third-order stream, 1 lake, and 1 nonforested wetland. Clearcuts or overstory removal harvests resulted in 8 of these sites, while the remaining 12 sites involved partial harvests.

Discussion:

BMP use and effectiveness reported here indicate that there is substantial room for improvement in rate of application of BMPs. Appropriate BMP use does appear to result in reduced likelihood of soil movement and delivery to surface water bodies. Major discharges of sediment to water bodies are not common, but minor delivery of sediment occurs more frequently. These occurrences most often result from failure to use BMPs. Small, intermittent and first-order perennial streams are by far the most common type of water body encountered. At the same time, the presence of water bodies on harvest sites is not as pervasive as might be expected, which may be at least in part due to harvest planning to avoid surface waters.

Trends in BMP use and effectiveness

Data reported in this study establish a baseline with which future results can be compared, and must largely be evaluated on their own. Historical information with which to compare findings is limited. Comparisons of future monitoring data with the present results will allow more complete analysis of trends, particularly if sample sizes per year remain relatively constant, methodologies remain consistent, and multiple periods can be evaluated.

The only relevant past information which may suggest trends is found in the study conducted by Briggs et. al[4]. (1996), for sites reviewed in 1993-1994. They evaluated 120 sites intensively over two field seasons, using rating systems and a methodology that were similar to, and served as the basis for, the present monitoring. The Briggs methodology was adapted for this study to increase efficiency (due to personnel constraints), provide continuous monitoring over time, and to focus effort on water quality issues, both topically and on the ground, identified by Briggs et al. and subsequent discussion by FORAT.

Important differences exist in both methodology and reporting of results between the Briggs report and this study. These differences stem from examination of individual BMPs vs. BMP issues, averaging ratings over multiple vs. single observations, incorporation of planning BMPs explicitly vs. implicitly, a lack of reference in the Briggs study to actual presence of surface waters/water quality issues, and other issues. The direction of trends may be evident. However, the degree of actual difference is likely not quantifiable without additional re-analysis of the Briggs data.

Comparing BMP use, referred to in the Briggs study as “compliance”, is possible, although only indirectly, for similar BMP categories. Data for BMP “effectiveness” in the Briggs study were presented in graphical and tabular form, and were summarized very briefly, making overall comparisons difficult.

BMP Use

Table 6 shows summarized data in roughly comparable BMP use categories. While the “categories” used in the Briggs study are not identical with those in this study, they do form a basis for limited comparison of BMP application. The results in this report appear to suggest some increase in BMP use. However, a direct comparison is impossible without reanalyzing the Briggs data.

The Briggs study derived "compliance" with each individual practice based on the number of sites where the practice was applicable. Sites were considered "compliant" if BMP use was rated "exceeded/met BMP recommendations" or had a "minor departure" from recommendations. "Overall compliance" for several broad BMP groupings was calculated based on an average of compliance for individual practices within each grouping, weighted by the number of applicable sites for each practice.

A similar summary rating of BMP use is derived in Table 6 for BMP categories in this report, by adding the percentages of sites with BMPs used "appropriately" and those with a "good attempt".

Several of the methodological differences that hinder direct comparisons would likely tend to inflate the overall "compliance" in the Briggs study, or increase the likelihood of identifying sedimentation in the current study. Therefore it is encouraging that BMP use in this study is generally the same or higher than that found in the Briggs study. However, these comparisons should not be viewed quantitatively as evidence of an identifiable degree of improvement.

BMP "Effectiveness"

The Briggs study did not report "overall effectiveness", and only reported the number of sites where sediment reached the water for individual BMPs, not by BMP category or for the study as a whole. BMP effectiveness was evaluated primarily in relation to BMP use. The total number of sites that actually had surface waters was not reported.

Sediment delivery to surface waters, including "significant sediment" or "some sediment" delivered, was reported on 0-100% of the applicable sites for individual BMPs. "Planning" BMPs were not included/rated for BMP effectiveness, since it was impossible to rate evidence of sediment movement directly related to these practices. The highest occurrence of sediment delivery for a single BMP was 30 stream crossing sites (including both "compliant" and "noncompliant" sites) involving the practice "crossing at a right angle with reasonably level approaches".

In all, 34 of the 120 total sites (28%) in the Briggs study had "a downstream sediment trail" due to noncompliance with BMPs. This figure does not reflect how many sites actually had surface waters, nor does it include additional sites with sediment delivery to surface waters in spite of BMP compliance, which occurred in connection with many individual BMPs. Perhaps the best inference regarding presence of water bodies is from BMP #7, "keep roads 75 feet from streams and 250 feet from lakes", which was applicable on 89 of 120 sites. If this number reflects the number of sites with water bodies, then at least 34 of 89 sites, or 38% of sites with water bodies, had sedimentation.

The comparable figures in this study indicate that 60 of 317 sites, or 19% of all harvested sites (with or without surface water present), had major or minor sediment movement and delivery to surface water. On the181 sites with water bodies, the same 60 sites represent 33% that had sediment delivery.

In summary, these comparisons suggest that the trend for both BMP use and effectiveness is positive, but absent a reanalysis of Briggs results, the degree of improvement cannot be quantified.

Table 6. Comparison of BMP Use / "Compliance"

Briggs et. al. (1993-1994)		**This report (2000-2001)**
	% sites with BMPs "compliant".	*% sites with BMPs used appropriately or "good attempt"*
"Haul roads"* "Retiring trails and roads"*	69 54	70.7 (haul road filter strips/drainage systems)
"Skid trails"* "Retiring trails and roads"*	67 54	81.1 (skid trail channeling of water)
"Stream crossings" (all)	74	73.7 (haul road crossings) 59.1 (temporary/logging crossings)
"Streamside Management Zones"	69	85.9 (logging filter strips) 70.7 (haul road filter strips/drainage systems) 84.5 (residual shade adequate, no reduction)
*may include observations/sites not in proximity to surface water bodies		

Future monitoring

While the methodology appears to have been effective, there may be modifications that could improve the information collected in future. Several of these issues were discussed by FORAT's quality control team. The proportion of sites on different ownership types has already been noted, and selection of sample sites could potentially result in a more representative sample.

The number of sites where harvesting is active at the time of the survey could be increased. Sites reported here are roughly evenly distributed among operations that were active at the time of the field visit (110 sites), operations that had been completed within the past year (117 sites), and operations that had been completed more than a year prior to the field visit (90 sites). Sites with water were found in all parts of the state, with 10 to 27 such sites in each of 9 districts. Sites with water were somewhat more commonly active or recent harvests (77 and 64 sites, respectively) than older harvests (40 sites).

A significant question concerning the methodology was whether snow cover and snow depth (i.e. winter conditions) affected the likelihood of finding water on a given site. However, the proportion of sites that had water bodies was virtually identical for sites visited in the winter months (December through March) compared with sites visited in nonwinter months (April-November). Of 79 sites visited in winter, 45 (57%) had water bodies, while 136 of 238 sites (57.1%) of sites visited during nonwinter months had water. The result reflects the fact that 37 sites where no data could be collected due to snow depth, or which were inaccessible (largely due to snow), are not included in the total number of sites. It should be noted that the winter of 2000-2001 was a particularly snowy one. A modified methodology may present a clearer picture of winter harvest activity.

Acknowledgements:

This report has been made possible through the efforts of the members of FORAT (Forestry Advisory Team), who have been instrumental in developing and supporting BMP monitoring in Maine. Several members of FORAT also contributed considerable additional effort by serving on the quality assurance/quality control team. Maine landowners who participated in monitoring and/or permitted monitoring to go forward on their lands deserve special thanks. Several key MFS staff, especially Roger Ryder and Greg Lord, have provided invaluable service in developing and providing logistical support for the monitoring.

This report would have been impossible without the countless hours of dedicated field work by the Foresters and Rangers of the Maine Forest Service.

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[1] Briggs, R., Kimball, A., Cormier, J. 1996. Assessing compliance with BMPs on Harvested Sites in Maine: Final Report. University of Maine, Cooperative Forestry Research Unit Research Bulletin 11. 35 pp.
[2] Maine Forest Service, 2001. 2000 Silvicultural Activities Report. Department of Conservation, Augusta, Maine.
[3] Ibid.
[4] Briggs et. al., op. cit.

Appendix 1. The following two tables present the same information for ease of use. Table 3(a) is organized based on "Effectiveness" (Impact) ratings, while Table 3(b) is organized based on "BMP use" ratings.

Table 3(a). Effectiveness/use matrix by BMP Category

		Skid trail channeling of water		Temporary (Logging) Stream Crossings		Logging Filter Strips		Haul Road Stream Crossings		Haul Road Filter Strips & Drainage Systems		Overall	
		(169 sites)		(83 sites)		(156 sites)		(76 sites)		(75 sites)		(181 sites)	
Effectiveness (Impact)	**BMP Use**	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Ineffective, major soil movement	BMPs not applied	3	*1.8*	4	*4.8*	4	*2.6*	1	*1.3*	3	*4.0*	11	*6.1*
"	Minimal attempt	1	*0.6*	1	*1.2*	0	*0*	0	*0*	0	*0*	1	*0.6*
"	Good attempt, needs improvement	0	*0*	0	*0*	0	*0*	1	*1.3*	0	*0*	1	*0.6*
"	BMPs used appropriately	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*
Ineffective, minor soil movement	BMPs not applied	10	*5.9*	5	*6.0*	2	*1.3*	8	*10.5*	6	*8.0*	18	*9.9*
"	Minimal attempt	4	*2.4*	5	*6.0*	1	*0.6*	1	*1.3*	5	*6.7*	12	*6.6*
"	Good attempt, needs improvement	5	*3.0*	1	*1.2*	1	*0.6*	10	*13.2*	4	*5.3*	14	*7.7*
"	BMPs used appropriately	1	*0.6*	2	*2.4*	1	*0.6*	0	*0*	0	*0*	3	*1.7*
Soil movement, does not reach water	BMPs not applied	4	*2.4*	2	*2.4*	4	*2.6*	0	*0*	3	*4.0*	10	*5.5*
"	Minimal attempt	3	*1.8*	3	*3.6*	1	*0.6*	10	*13.2*	2	*2.7*	5	*2.8*
"	Good attempt, needs improvement	11	*6.5*	9	*10.8*	6	*3.8*	6	*7.9*	6	*8.0*	13	*7.2*
"	BMPs used appropriately	8	*4.7*	0	*0*	2	*1.3*	2	*2.6*	0	*0*	9	*5.0*
Negligible soil movement	BMPs not applied	3	*1.8*	10	*12.0*	8	*5.1*	0	*0*	2	*2.7*	7	*3.9*
"	Minimal attempt	4	*2.4*	3	*3.6*	2	*1.3*	0	*0*	1	*1.3*	3	*1.7*
"	Good attempt, needs improvement	9	*5.3*	5	*6.0*	5	*3.2*	3	*3.9*	5	*6.7*	10	*5.5*
"	BMPs used appropriately	102	*60.4*	32	*38.6*	119	*76.3*	34	*44.7*	38	*50.7*	63	*34.8*
Ineffective, minor soil movement	BMPs used after the fact			1	*1.2*								
Negligible soil movement		1	*0.6*									1	*0.6*

Table 3(b). Use/effectiveness matrix by BMP Category													
		Skid trail channeling of water		Temporary (Logging) Stream Crossings		Logging Filter Strips		Haul Road Stream Crossings		Haul Road Filter Strip &Drainage Systems		Overall	
		(169 sites)		(83 sites)		(156 sites)		(76 sites)		(75 sites)		(181 sites)	
BMP Use	**Effectiveness (Impact)**	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
BMPs not applied	Ineffective, major soil movement	3	*1.8*	4	*4.8*	4	*2.6*	1	*1.3*	3	*4.0*	11	*6.1*
"	Ineffective, minor soil movement	10	*5.9*	5	*6.0*	2	*1.3*	8	*10.5*	6	*8.0*	18	*9.9*
"	Soil movement, does not reach water	4	*2.4*	2	*2.4*	4	*2.6*	0	*0*	3	*4.0*	10	*5.5*
"	Negligible soil movement	3	*1.8*	10	*12.0*	8	*5.1*	0	*0*	2	*2.7*	7	*3.9*
Minimal attempt	Ineffective, major soil movement	1	*0.6*	1	*1.2*	0	*0*	0	*0*	0	*0*	1	*0.6*
"	Ineffective, minor soil movement	4	*2.4*	5	*6.0*	1	*0.6*	1	*1.3*	5	*6.7*	12	*6.6*
"	Soil movement, does not reach water	3	*1.8*	3	*3.6*	1	*0.6*	10	*13.2*	2	*2.7*	5	*2.8*
"	Negligible soil movement	4	*2.4*	3	*3.6*	2	*1.3*	0	*0*	1	*1.3*	3	*1.7*
Good attempt, needs improvement	Ineffective, major soil movement	0	*0*	0	*0*	0	*0*	1	*1.3*	0	*0*	1	*0.6*
"	Ineffective, minor soil movement	5	*3.0*	1	*1.2*	1	*0.6*	10	*13.2*	4	*5.3*	14	*7.7*
"	Soil movement, does not reach water	11	*6.5*	9	*10.8*	6	*3.8*	6	*7.9*	6	*8.0*	13	*7.2*
"	Negligible soil movement	9	*5.3*	5	*6.0*	5	*3.2*	3	*3.9*	5	*6.7*	10	*5.5*
BMPs used appropriately	Ineffective, major soil movement	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*	0	*0*
"	Ineffective, minor soil movement	1	*0.6*	2	*2.4*	1	*0.6*	0	*0*	0	*0*	3	*1.7*
"	Soil movement, does not reach water	8	*4.7*	0	*0*	2	*1.3*	2	*2.6*	0	*0*	9	*5.0*
"	Negligible soil movement	102	*60.4*	32	*38.6*	119	*76.3*	34	*44.7*	38	*50.7*	63	*34.8*
BMPs used after the fact	Ineffective, minor soil movement			1	*1.2*								
"	Negligible soil movement	1	*0.6*									1	*0.6*